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ABSTRACT

Issues concerning research partnerships between universities and industry are reviewed. Attention is directed to: the genesis of partnerships, a typology of linkages, salient incentives for academe and commerce, currently perceived barriers, qualitative assessment of linkages, and recommendations for the improvement of partnerships. Linkages fall into three main categories: general research support, which includes gifts, equipment donations, and endowments; cooperative support and knowledge transfer via both institutional and personal interactions; and formal technology transfer, which includes industry parks, extension teaching, and research institutes. Incentives of universities for linkages with industry include: new sources of funds for basic research and graduate student training: new sources of equipment, labs, and instrumentation; exposure to real world research; income from patent rights; and an alternative to government research funds. For corporations, the incentives include: acquisition of personnel, translating theories and innovations into marketable products, access to university facilities, and increased productivity. Mutual barriers pertain to institutional differences, patent rights and licensing questions, and concepts of planning. A bibliography that includes "fugitive literature" is appended. (SW)

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Research on University-Industry Linkages: The State of the Art

DRAFT

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May 1984

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Paper presented at the 1984 AIR Forum in Forth Worth, Texas

THE ASSOCIATION FOR INSTITUTIONAL RESEARCH

This paper was presented at the Twenty-Fourth Annual Forum of the Association for Institutional Research held at the Hyatt-Regency in Fort Worth, Texas, May 6-9, 1984. This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of Forum papers.

Daniel R. Coleman, Chairman
Forum Publication
Advisory Committee

Research on University-Industry Linkages:
The State of the Art

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INTRODUCTION

During the past few years, research on university-industry linkages has received tremendous attention. Never before in the history of higher education has knowledge been translated into application so quickly, and yielded return in the marketplace so heavily. In the process, partnerships have been criticized by those who fear that academic values are disrupted by corrupt commercial expectations and supported by those who feel that application is the very essence of knowledge. Thus, the basic question seems to be whether institutions of higher learning can align themselves with the business world without compromising their mission of learning, research, and service to society. Without proposing an answer, this article attempts to capture some of the problems and prospects of university-industry linkages by reviewing the state of the art regarding research and partnerships. In addition, fairly comprehensive NSF funded studies, individual state study groups and university teams have begun to research the linkage process in greater detail. Systematic knowledge now is emerging on the types of linkages being formed and the successes and benefits being generated. In this article the following aspects shall be presented: (1) the genesis of partnerships, (2) a typology of linkages, (3) salient incentives for academe and commerce, (4) currently preceived barriers, (5) qualitative assessment of linkages, and (6) recommendations for the improvement of partnerships. With still only a small amount of formally published material available beyond specific case studies, the appended bibliography includes an array of "fugitive literature," which may assist the reader in pursuing specific phenomena.

I. THE GENESIS OF PARTNERSHIPS

University-industry linkages are oftentimes heralded as something new. This is clearly not the case as a review of case studies indicates. For decades, industry has supported higher education and research by providing research grants, student scholarships, and equipment. However, as Derek Bok, President of Harvard University, points out in his article "Business and the Academy" (1980), after 1950, the U.S. Federal government began to increase its support for scientific research by such magnitude that industry-university relationships declined, in relevance and significance. Today, the trend in the U.S. is once again toward the other side of the pendulum: Federal grants to universities are decreasing, NASA is de-escalating its programs, and state support for higher learning is eroding in the competition for social service monies. Universities, then, overbuilt and overstuffed as many would contend, need commerical support to fill the financial void.

The current impetus for increasing partnerships however goes beyond a short-term, one-sided need; indeed, motivations exist on both sides of the camp. The unfolding information age, post-industrial society, high technology era -- whatever the label may be historians eventually attach to the descent of the manufacturing age and the dawn of the computer age --has hit more suddenly, and totally, and competitively than anticipated. Most importantly, the new age hit at a time when most Western countries are suffering from a deep recession, leaving many educational systems unable to acommodate the change. While industries need graduates trained in the rapidly proliferating aspects of high technology, universities are unable to provide the advanced equipment and labs for training, not to mention the capital for major curricular alternations, including hiring new faculty. One could even argue that the scope of the need goes well beyond the concern for the welfare of the American education system and the marketplace, and instead relates to the Western quest for commerical supremacy in post-industrial society. The National Commission on Excellence in Education in its recently released "Report to the Nation," states in the opening paragraph:

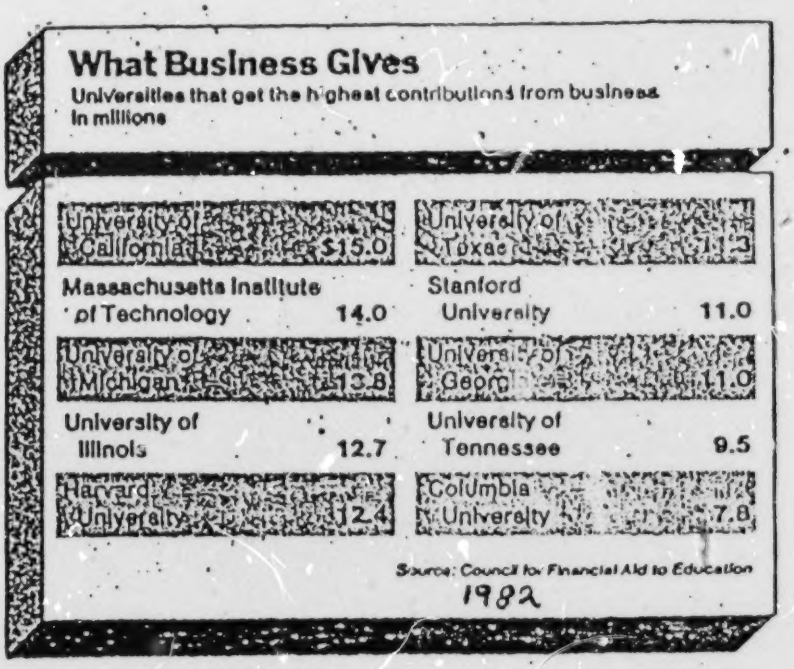
"Our Nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovaton is being overtaken by competitors throughout the world. This report is concerned with only one of the many causes and dimensions of the problem, but it is one that undergirds American prosperity, security, and civility. We report to the American people that while we can take justifiable pride in what our schools and colleges have historically accomplished and contributed to the United States and the well-being of its people, the educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people. What was unimaginable a generation ago has begun to occur -- others are matching and surpassing our educational attainments."

How then do university-industry partnerships evolve? Anybody looking at such relationships seems to focus on the Silicon Valley in California, Route 128 in Massachusetts, or the Research Triangle in North Carolina. All three share necessary ingredients for successful partnerships, including:

(1) a cluster of universities active in many aspects of research and graduate training;
(2) a limited geographic region whose close-knit identity constitutes an intellectual challenge and a healthy competitiveness, yet provides access to air traffic and a commercial metropolis;
(3) an entrepreneurial receptivity to new ideas on the part of surrounding industries, a receptivity which is driven by a need for brains and skilled labor; and
(4) a political support system that provides venture funding, tax incentives, and courageous leadership.

(Congress of the United States, Staff Study of the Joint Economic Committee, 1982)

But while the above mentioned examples make impressive case studies, their mention here does not address the question as to how university-industry partnerships typically tend to evolve. In a 1982 study of 340 relationships by the National Science Foundation, it was found that institutional linkages are frequently the result of consulting relationships (Kruytbosch, 1982, p. 70). In 66% of those consulting relationships, the university was the initiator. It is during consulting visits then that a professor sees interesting activities and perhaps the potential for a research relationship. Under the umbrella of mutual need, previously held prejudices of "the other side" begin to crumble. As research ideas and equipment and/or money are exchanged, so are students, and-eventually-graduates. "The web of contacts thus becomes denser and the cycle is repeated in future years" (p. 73). Kroytbosch concludes that university-industry partnerships are historical and sequential, and that formal linkages flow from informal contacts. And while the press concentrates on high dollar volume relationships (see below), there are hundreds of smaller partnerships which deserve to be recognized, particularly by those comtemplating such ventures themselves.



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II. TYPOLOGY OF LINKAGES

What constitutes a university-industry linkage? A phone-call?, sponsoring a student assistantship?, a donation?, a multi-year joint research project? The answer is that all of these activities belong under the global umbrella of the term "linkage." It becomes clear very quickly that in order to study and assess linkages one has to begin by establishing a typology of linkages. Such research has developed more momentum during the past couple of years, to the point where fairly comprehensive typologies are in existence which in turn lend themselves to borrowing and expanding upon in specific/local studies. The National Science Foundation in a recent summary of studies in this area cites a project which entailed 95 institutions. Based on site-visits with these colleges, the typology table (see page 6) was developed.* Basically, linkages fall into three main categories:

(1) general research support which includes gifts, equipment donations, and endowments.
(2) cooperative support and knowledge transfer via both institutional and personal interactions.
(3) formal technology transfer which includes industry parks, extension teaching, and research institutes.

*The study cited and table presented here is from the Center for Science and Technology Policy, New York University, Lois S. Peters, Research Associate, and Herbert I. Fusfield, Director.

A TYPOLOGY OF RESEARCH INTERACTIONS

General Research Support	Cooperative Research Support Knowledge Transfer		Formal Technology Transfer
A. Institutional Gifts In Support of Research	A. Institutional Agreements	A. Personal Interactions	A. Product Development and Modification Programs
1. Monetary Gifts	1. Contract Research	1. Personnel Exchanges	1. Extension Services
2. Equipment Donations	2. Equip. Transfer & Loans	2. Mechanisms for Personal inactions, Seminar, Speakers	2. Innovation Centers
3. Contributions for Research Facilities	3. Grants to a Professors	3. Adjunct Professorships	
	4. Graduate Fellowships	4. Consulting	
	5. Gov't Funded U/I Cooperative Research		
B. Endowment/Annuity/ Trust Funds	B. Group Arrangements	B. Institutional Programs	B. Univ. and/or Industry Associated Institutions Serving as Interface for U/I Research Interactions
1. Research Facilities	1. Special Purpose Industry Affiliate Programs	1. Consultin,	1. Technology Brokering Licensing Activities
2. Endowment Chair	2. Research Consortia	2. Industry Associates Programs	2. University Connected Research Institutes
			3. Industrial Parks
			4. Spin-Off Companies
	C. Institutional Facilities	C. U/I Cooperation & Education	
	1. Coop. Research Centers	1. Internships, U/I Coop. Training Programs	
	2. Univ. Based Institutes Serving Industial Needs	2. U/I Coop. in graduate curriculum development;	
	3. Jointly Owned or Operated Facilities & Equipment	3. Continuing Education	
		4. Fellowships	
	D. Informal Cooperative Interaction: Co-authored papers, Equipment Sharing	D. Collective Industrial Interactions, i.e., research consortia	

Adapted from NSF, 1983, p.60

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In terms of frequency, the study reports the following data:

The Spectrum of Interactions Documented in NYU Field Study

Types of Interactions	% of Interactions Documented Falling Into Each Category	(N)*
All Categories of Interactions	100	(464)
• General Research Support	11	(54)
• U/I Cooperative Research	61	(284)
• Knowledge Transfer	13	(58)
• Technology Transfer	14	(68)

Adapted from NSF, 1983, p. 16

As mentioned before, research on typpologies of partnerships, particularly for specific institutions or regions, is currently burgeoning as institutions try to learn more about such arrangements. One such study is presently conducted jointly at four Michigan Universities (University of Michigan, Michigan State University, Wayne State University, Michigan Technical University). In addition to establishing its own typology of partnerships, the study also takes a look at the purposes and utilities of linkage organizations such as councils, institutes, centers, research parts, extension services.

III. ANALYSIS OF INCENTIVES AND BENEFITS

In the previously cited summary of selected studies by the NSF, heavy emphasis is placed on the question as to why universities and industries are interested in linkages (NSF, 1983) and how that information in turn can be used by the two sides to accommodate these motives, incentives and expectations to an optimal extent. This section is an attempt to gather informaton on motives academe (A) and corporations (B) have come to identify as initiating forces for partnerships.

A. HIGHER EDUCATION INCENTIVES

1. New Sources of Funds for Basic Research and Graduate Student Training.
   The above cited study by the NSF found that the acquisition of additional funds is the primary motivation on the part of universities. There is particular interest in securing so-called unrestricted funds, which obviously provide institutions with the freedom to allocate at their own discretion.
2. New Sources of Equipment, Labs, and Instrumentation.
   In recent months, the flow of equipment from industry to universities has assumed phenomenal proportions. Outright gifts and grants of equipment, mainly computers, as well as various kinds of cost-sharing and matching at the multi-million dollar level are not uncommon. While such arrangements allow companies to present their wares to faculty and students (and future buyers), universities are able to join the high tech era at a speed their regular budgets would not have allowed them. The benefits are obviously discipline-specific, an aspect which sometimes troubles the typical non-recipients, e.g., humanities faculty and students.

As a result of this current "scientist versus humanist" controversy, one of the arguments being flaunted is that, today, high technolcgy literacy is as valuable and necessary as written literacy.

3. Exposure to Real World Research.

The NSF study found that the discrepancy between "lofty" university research and commercial needs is a very substantial concern. Thus, the access to industrial labs to faculty and students provides a bridge from theory to application, as well as usage of more advanced instrumentation.

4. Income from Patent Rights.

Clearly, reported income from patents is impressive (see below) and is therefore mentioned as a primary incentive. However, these statistics do not tell the whole story. First, there are relatively few institutions that succeeded in producing a big "hit" patent in terms of commercial marketability. Second, the figures do not mention the expense side of the innovation, the people involved, the years needed, and the number of ideas that were aborted. Literature seems to support the notion that universities embarking on linkages with the primary objective of gaining form patent rights may very well face disappointment.

The big winners

School	Patent	Year	Licensee	Revenues
Michigan State University	Platinum-complex drug for cancer therapy	1979	Bristol-Myers	$1.8 million ($25 million anticipated)
Massachusetts Institute of Technology	Core memory for computers	1956	International Business Machines	$19 million
University of Wisconsin	Synthesis of vitamin D	1927	More than 400 licensees	$14 million
Massachusetts Institute of Technology	Synthetic penicillin	1964	Bristol-Myers	$10 million
Columbia University	Burn ointment	1973	Marion Laboratories	$1.75 million ($5 million anticipated)
State University of New York	Radiopharmaceutical for X-ray imaging of bones	1976	New England Nuclear, Squibb, and others	$600,000 ($4 million anticipated)
Iowa State University	Use of diethylstilbestrol as an animal feed additive	1956	Eli Lilly	$3.5 million
Columbia University	Original patent for lasers	1959	Westinghouse, GE, and 40 others	$3.5 million

Data: Research Corp., BW

5. Alternative to Government Research Funds.
As federal funding sources are drying up, universities feel forced to explore other options. Also, industry funds may provide universities with the opportunity to decline federal research monies that do not adhere to a particular institutional ideology and value system, i.e., federal defense research.

B. CORPORATE INCENTIVES

1. Acquisition of Personnel.
By far the most frequently mentioned incentive here refers to universities supplying industry with student assistants, graduates, and scientists. Universities also function as centers for human resource development, i.e., training and redirecting personnel. Indeed, looking at corporate systems of management, it is fair to say that, typically, the entire infrastructure is a product of university training. Support of these training centers then constitutes a matter of self-interest to corporate firms.

2. Window on New Science and Technology.
Corporate executives believe that universities warrant support because they are the seedbed for new ideas and, in increasing measures, contribute to translating theories and innovations into marketable products.

3. Support of Technical Excellence and Variety.
Because corporate raisons d'êtres dictate that production be timely and profit-oriented, there is little impetus for and less respect for researching beyond the prescribed path and in a mode of quality and excellence. Linkages with universities, however, provide access to those attributes and indirect benefits.

4. Access to University Facilities.
University-industry partnerships also provide industry with access to libraries, entire clusters of related experts and interdisciplinarian thinkers, as well as insight into lab and research activities in many different areas. Although not

always equipped with the latest invention, these facilities and their users nonetheless may very well spark ideas for new products and solutions. One mechanism to secure linkages here has been for universities to offer affiliation with a specific department. For instance at the University of Michigan, corporations can assume affiliation with a specific department for as little as 5,000 Dollars and as high as 20,000 Dollars per year (depending upon the field, the type and size of the corporation and the scope of te benefits involved).

5. Increase in Productivity.

Much has recently been written about the plateauing and perhaps declining level of productivity in the U.S. The causes for this phenomenon cannot be solved by one company, with one product, or with one improvement. The quality of education in general, the psychological health of society, the technical and managerial training of corporate infrastructures affect productivity. While industry can influence some of these, it is once again the linkage with universities that enhance the chance and process toward renewal.

6. Quality of Life.

Proximity to a university has many advantages to a corporation. In addition to incentives with respect to personnel and expertise, universities provide a special ambiance. Reduced crime rates, enhanced cultural and athletic environments, and a tolerance for alternative lifestyles constitute attractions and benefits to industry and its people.

7. Marketable Prestige.

Using the name of a prestigious university oftentimes lends credibility and prestige to a product. Particularly in the medical field, the citing of university scholars is used to underscore social concern and scientific objectivity to the item being marketed.

IV. BARRIERS TO MORE AND BETTER LINKAGES

Having identified sets of incentives from both perspectives, it is equally important to identify current barriers to constructive linkages. As the issues below bear out, these problems are true dilemmas in the sense that they reflect basic differences in goals, values, and operational philosophies, rather than person-specific or project-specific hindrances. A description of mutual problems (A), specific barriers to higher education (B) and industry (C) shall be discussed.

A. MUTUAL BARRIERS

1. Institutional differences.

Of course much has been written about the difference between academe and commerce: different lifestyles, values, levels of quality, and tolerance for ideosyncracies on the part of the people, differences in organizational behavior, norms and processes, etc. While some of these differences exist, others are carefully cultivated sterotypes and long-held perceptions, myths, and prejudices. Perceptions of the hard-driving, profit-oriented corporate manager and the theory-minded professor need to be over-come before larger ventures are contemplated and more people drawn into partnerships. Recently, both academe and commerce are attempting to influence and convince people otherwise by organizing workshops for corporate folks that address corporate ethical/societal responsibilities, and seminars for academics that teach concepts of entrepreneurships, profit accounting, and marketing. The purpose obviously is one of learning more about each other and appreciating the other territories.

2. Patent Rights and Licensing Questions.

'Who owns the research outcome?' is the question that emerges sooner or later in almost all partnerships. Having financed a specific research process, the supporting industry feels that it deserves exclusive rights to the outcome and subsequent commercial marketing. Universities, however, feel that, first, no specific project fund truly covers the collective knowledge available at a research institution. Second, universities prefer to have influence over the application of research findings in order to prevent facilitating activities that go against academic ethics and/or institutional values. For instance, while defense research may be acceptable, specific usage of equipment, chemicals, etc. may not. Other problems and concerns have emerged in the areas of genetic and environmental research. Finally, universities also increasingly object to corporations "picking up and runnning" with their inventions. Thus, getting a piece of the commercial action is a third reason why universities are reluctant to hand over exclusive patent rights.

3. Concepts of Planning.

It is often said that communication between academe and commerce is so difficult because the former tends to approach research from a long-term impact perspective whereas the latter adheres to a short-range planning concept. This problem has become more obvious in recent years. The basic reason is that, in the past, the government has been the facilitator and underwriter of long-term, comprehensive research projects in academe. As the Federal government has begun to de-escalate its research and development support to universities, industry is now asked to support (indirectly) long-term projects which on the surface may not be related to a product a given corporation is interested in. This situation has caused reluctance as well as confusion on the part of colleges, corporations, and the government as to what their respective roles and priorites in society are.

B. BARRIERS FROM THE ACADEMIC PERSPECTIVE

1. Academic Independence.

Nothing is feared more in colleges than the potential of losing or compromising academic values and goals in order to attract commercial funds. Temptations are constantly there: the establishing of a named chair - with strings attached as to how the occupant is selected; the support for a specific program - with the intent to prescribe to a specific ideology; the research project - that tries to circumvent quality control and research ethics. Thus, the loss of objective judgment about quality and purpose is a concern of utmost importance to higher education. While faculty groups and other advisory groups try to work out the ethical issues, universities have begun to circumvent some of these questions by establishing linkages organizations, i.e., research corporations. These entities basically are organizational structures functioning as more or less independent facilitators between universities and industry. A NSF funded study currently being conducted at four Michigan universities is (among many other objectives) trying to identify the types of linkage agencies currently in existence and to assess the scope of their utility and impact.

2. Internal Equity.

Ever since the emergence of natural science in the Middle Ages, higher education had to balance the role and relative importance of the humanistic versus the scientific curriculum. While the current quest is for the sciences, most universities are unwilling to let external market forces control their internal division of priorities, support, and funds. Indeed, the few concessions (e.g., higher salaries) being made for engineers, computer sciencists, etc., are cloaked in "temporary" verbiage such as interim market adjustment, or temporary need consideration.

3. Concerns About Environmental Impact.

Universities see themselves as preservers of values and quality of life for society. Nothing has stirred more objection to policies and projects than those that may damage the environment, pollute the air, kill the wildlike, and reduce the open spaces. Intense objection has focused on nuclear and military research that may threaten humanity itself. Thus, it is understandable that while a given corporation is only interested in developing a specific chemical, universities may reject the project on the grounds that potential application in warfare or land exploitation may be irreconcilable with their quality of life philosophy.

Environmental impact is also occurring in a different sense. As more corporations begin to settle in close proximity to university research parks they begin to alter the local real estate structure, patterns of job mobility, as well as impact in general on the landscape and mix of people in university cities. Originally an exciting place to be, famous Silicon Valley has since become an example of how not to let success and development get out of control.

C. BARRIERS FROM THE CORPORATE PERSPECTIVE

1. Risks

From the corporate perspective, projects need to be timely and therefore have to be self-contained. Participation on the part of academics cannot depend on semester schedules, student assistant availability, and fit with class work or publication interests. Further, little understanding is generated for such delays as reviews by ethic committees and collegiate clearance procedures. Sometimes the implication is that a "quick and dirty" approach is preferred over a tedious, high quality theoretical one. Feedback from corporations is that the academic world has little awareness of the pressures in the marketplace;

if lured to teach in-house, faculty tend to be too theoretical, too "jargony." As a result of this inability to communicate, industry has begun to establish its own in-house personnel development programs and, in fact, its own colleges (e.g., IBM, GM, WANG, AT&T, Holiday Inn, etc.). Finally, an immense rise in the number of independent consulting firms providing liaison between higher education and commerce is testimony to a need for thinking and advising that is independent of organizational rules, norms, and existing infrastructures.

2. Proprietary Rights.

Related to the patent question is the issue of who holds proporietary rights. The question is more complex though because commercial marketability of research outcomes are difficult to estimate. Does the discovery lead to one sales item, to several thereafter? Who is the licensor? Who holds responsibility for quality control and safety? (Case studies about the Whitehead Institute, liaison with Harvard University; MEIS Center, University of Minnesota, liaison with Honeywell, and other corporations, reveal interesting agreements, clauses, and organizational linkages). As mentioned before, another solution gaining in popularity is the creation of research corporations initiated by the university but organizationally and financially detached. These linkage organizations provide a vehicle to temporarily lure faculty who can then assume the role of entrepreneurs for their project; they allow for disassociation from university bylaws and rules, as well as the existing internal academic salary structure. While this solution seems to present many advantages, it is the non-science faculty, humanists and social scientists, who are resentful of the inequities and status differentials being created.

Related to the proprietary question is the issue of right to publication. While academics typically would like to maintain open scientific communication (that is, publish results as soon as substantiated), industry would prefer to maintain a cloak of secrecy, at least during the evolutionary stages of the product.

3. Tax Laws and Venture Funding.

A final and rather important barrier to partnerships often rests in existing tax structures. To what extent do local or state laws allow for tax deductions for venture funding, for deductible "gifts" to non-profit organizations? Also important are labor laws, union agreements, and especially the extent to which industry is taxed for social services, such as unemployment. While these issues may seem far-fetched as far as university-industry partnerships are concerned, the tax situation very much influences corporate thinking as to where to settle, whom to support, and when to decide for partnerships with non-profit organizations.

V. QUALITATIVE ASSESSMENT OF LINKAGES

This is an area still in need of extensive research. The basic question here is as problematic and controversial as those arising in program reviews, or even tenure reviews: How does one assess, preferably quantitatively, the quality and substance of a product, an outcome, a publication? While we can measure the number of faculty and graduates being hired or consulted by a local industry, while one can assess the value of equipment gifts or outright donations, it is almost impossible to evaluate the flow of ideas and the cross-pollination of interests and experience. So far, only procedural phenomena have been identified.

A. Success Critera

There is agreement at this time on the fact that the best success predictor is the availability of an individual who assumes leadership and initiative in the pursuit of linkages and who in turn draws others into the partnership. A second criteria is the existence of a program, lab, or center through which a specific project can be sponsored and supervised.

B. Failure Critera

Looking at case studies as to why conceivable linkages have not been established, it was observed that corporations are reluctant to fund a project if it involves the creation of a new organizational entity to accommodate the project (NSF, 1983). Obviously, a second criteria would be if expectations are not being met, i.e., that the research did not produce a marketable product. Additional potential failure criteria could be that a project was not performed within the prescribed timeframe, i.e., in line with corporate production cycles, or that the focus of the research was too much on the basic rather than the applied side.

Although still in an embryonic state at this stage, it is expected that current research on linkages will soon yield good suggestions and ideas on how institutional researchers can assist in cost-benefit studies regarding university-industry partnerships.

VI. RECOMMENDATIONS FOR THE IMPROVEMENT OF PARTNERSHIPS

A. Expand Upon the Research on Typologies of Partnerships

It is recommended that the typologies of partnerships be expanded to include complex arrangements. While partnerships between single and multiple universities and single and multiple corporations have been observed, no comprehensive data exist as to where the preferences rest and what the

qualitative differences are. The previously mentioned NSF study summary found that more benefits seem to be derived in partnerships between one university and a network of corporations. The following spectrum may serve as a point of departure for future research (Kennedy, 1981):

1. University as licensor, collecting royalties directly.
2. Separate corporation as licensor, developer, and supporter of research; no relation to the university except through agreed sharing of royalty income.
3. Separate corporation as licensor, developer, and supporter of research; university faculty/administrators involved in governance.
4. Separate corporation as licensor, developer, and supporter of research; would also engage in final production. No university involvement, though faculty could be involved in governance.
5. Separate corporation as licensor, developer, and supporter of research; would also engage in final production. Univerisity faculty/administrators involved in governance; university has equity position.

B. Review of Patent Rights and Tax Structures

It is recommended that comparative analyses be conducted which review these issues within the environment of successful and unsuccessful, profitable and deficient, insignificant and comprehensive partnerships. As a result, more concrete recommendations ought to emerge that address the necessary changes in the broader tax and legal environment.

C. Assessment of Impact of Partnerships

It is recommended that the transfer of knowledge from research universities to corporate application be estimated in quantitative and qualitative terms. To date,

the benefits of relationships can be extrapolated from the existing literature in very general terms only. To what extent do universities affect corporate output, infrastructures, their personnel acquisition? How much does a patent bring in the marketplace if pitted against the time and personnel it cost to develop? While patent and proprietary income figures are available for the more comprehensive partnerships, little information is available on an actual cost/benefit comparison level. Clearly, there is a need here for the development of appropriate paradigms for impact assessments.

D. Review of the Cost of Doing Research

It is recommended that analyses be conducted regarding the direct and indirect costs of doing research. Much energy has been expended on federal projects with respect to cost reimbursement to universities for direct project expenditures and indirect expenditures for operating a research institution. While it seems desirable to avoid developing immense paper work, it would be beneficial to achieve greater awareness regarding costs, direct and indirect. Once this awareness exists, it would seem easier to negotiate the relative responsibilities on the part of the corporations toward their research partners.

E. Delineation of the Relative Roles of the Government, Higher Education, and the Industry

It is recommended that the Government review its obligation toward so-called comprehensive, long-range research(e.g., space research), as compared to project or issue-specific research on the part of the industry. Higher education ought not be put in a situation of flaunting its mission due to the lack of clarity regarding reasonable long-term commitments from government and commerce. Only if a realistic balance and harmony can be found between the Federal government, industry, and higher education can a concerted effort be staged to defend the desired status in

education and in the marketplace in the decades ahead.

CONCLUSION: REVIEW OF THE ROLE OF INSTITUTIONAL RESEARCH

It is recommended that the need for systematic research in this arena be evaluated. While it would seem quite natural for the corporate side to conduct cost-benefit analyses, universities typically have no good handle on evaluating the impact and utility of their commercial partnerships. Once brought into the management process, institutional research here ought to go far beyond the state of evaluating cost-benefits but in turn lay the groundwork for marketing positive outcomes, i.e., what and where are the markets that need to be informed, and what vehicle of communication should be used?

In Conclusion it seems fair to say that institutional research in the area of university-industry linkages appears to be an interesting new arena, yet awaiting new parameters to be developed and standards to be set.

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(5) The Inventor at Iowa: University of Iowa Research Foundation, a separate nonprofit corporation which handles various aspects of patents and other intellectual property, including dissemination of knowledge through the use of the patent system, licensing of patents to industry when appropriate, and supporting further research within the University. Established 1975.

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